[001] # ELECTROMAGNETICALLY ACTUATED TRANSMISSION BRAKE

[002]

[003]

[004] The invention relates to a transmission brake comprising one housing, at least one friction element, non-rotatably situated relative to the housing, and at least one other friction element, fastened upon a transmission shaft to be braked, the same as one actuation device by which one actuation element can be axially pressed against the friction elements.

[005]

[006] One such transmission brake was disclosed in DE 196 52 916 A1. Therewith it is possible, in an automated transmission in countershaft design, to suitably to decelerate the rotational speed of a countershaft with the gear wheels secured thereupon when, during an upshift operation for rotational speed synchronization, it is needed to reduce the rotational speed of the drive gear wheel of the higher gear. To carry out such deceleration operations, this known transmission brake has discs standing opposite to each other and non-rotatably and axially movably disposed on the end of a countershaft extending into the housing of the transmission brake or on the transmission brake housing. Moreover, in the housing of the transmission brake, one piston-cylinder arrangement is actuatable by pressure means with the piston of which the brake discs can be pressed against each other.

[007] Even though this known transmission brake is in itself very advantageously designed, it still needs a hydraulic pneumatic system which supplies the cylinder of the piston-cylinder arrangement with the pressure needed for actuating the brake. This really is not disadvantageous when there are also components in the vehicle other than the transmission brake which have to be supplied with a hydraulic or pneumatic actuation or control pressure. But since there are also vehicles in which the transmission brake is the only device needing a hydraulic or pneumatic actuation or control pressure, its installation in such a vehicle

constitutes a not inconsiderable cost factor. One basic disadvantage of fluid-controlled transmission brakes in piston-cylinder arrangements is, in addition, that they need comparatively much installation space for their added control components (such as magnetic valves) in an area of the vehicle which often is already very cramped.

[008] With this background, the problem on which the invention is based consists in introducing a transmission brake which can be actuated without a pneumatic or hydraulic pressure system and which also requires no large installation space.

[009] The solution of this problem results from the features of the main claim while advantageous developments and embodiments of the invention can be understood from the sub-claims.

[010]

[011] Accordingly, departing from a generic transmission brake, it is provided that the friction elements can be pressed against each other by an actuation element which is axially movable by an electromagnetic actuation device. This practical construction of the transmission brake makes it possible to omit a hydraulic or pneumatic system in the motor vehicle.

[012] In one preferred development of the invention, it is provided that the actuation device has one electromagnetically operative toroidal coil at its disposal which, controlled by a transmission control and regulation device, can be supplied with a coil current. In another variant of one toroidal coil, several separate coils also preferably form a circle.

[013] To reduce the installation space needed for the transmission brake, it can be further provided that the transmission brake can be completely or at least partly integrated in the wall of the transmission housing.

[014] In this connection, it is possible that the friction elements are situated at least partly in an aperture of the transmission housing wall into which extends the countershaft to be braked. An optionally overhanging section of the transmission brake, particularly the area that accommodated the toroidal coil, extends partly into the transmission housing or out of it.

[015] The toroidal coil can be fastened in a cover acting as housing for the transmission brake and which, for its part, is connected via fastening means with the transmission housing. The cover can also serve for covering other actuation devices which are fastened on the transmission housing wall. To form a good magnetic flow when loading the toroidal coil with an electric current, this housing is preferably made of a metallic material.

[016] With regard to the friction elements, it can be provided that they be designed as brake discs and be non-rotatably and axially movable situated upon the transmission shaft to be braked or on the transmission housing. For the propose, on the end of the countershaft extending into the housing of the transmission brake, there is made one outer plug-in toothing, while the aperture transmission housing is provided with one inner plug-in toothing. But in another variant of the invention, the friction elements can also be fixed in grooves of the countershaft or of the transmission housing by way of precision pins.

[017] As to the friction areas of the friction elements, it is deemed advantageous that the surface is corrugated, preferably sinusoidally corrugated.

[018] In another variant (version B) of he invention, for actuating the transmission brake and especially for compressing the brake discs that the latter has one armature coordinated with the coil, which is axially movably situated upon the plug-in toothing of the transmission shaft. It is deemed advantageous in this connection to place one ring armature, preferably disc-shaped, upon the transmission shaft, which is axially movable by the coil for compressing the brake discs.

[019] Moreover, upon the side of the transmission brake pointing away from the toroidal coil, one fastening disc can be situated on the plug-in toothing of the transmission housing or one radial spider on the countershaft, which makes possible, or at least supports, a one-sided axial fixing of the ring armature.

[020]

[021] For better understanding of the invention, the same as of the different embodiments thereof, with the description is enclosed one drawing showing a

diagrammatic cross sectional graph of the electromagnetically actuatable transmission brake.

[022]

[023]

[024] The transmission brake 1 accordingly extends in part of its axial length into an aperture of a transmission housing 2. In addition, into this transmission brake 1 extends in addition one transmission shaft 3 which has one outer plug-in toothing 10 in the area of the transmission housing wall 2. Upon the outer toothing 10 are non-rotatably and axially movably fastened friction elements 4, pointing radially outwardly and spaced apart from each other. In the intermediate spaces, the radially outwardly pointing friction elements 4 engage radially inwardly pointing friction elements 5, which are non-rotatably and axially movably disposed on the edge of the transmission housing aperture upon an inner plug-in toothing 11. The friction elements 4, 5 are here designed preferably as brake discs.

[025] Pointing away from the transmission shaft in the area of the side of the transmission housing wall 2, a housing 13 of a half wall design is connected with the transmission housing wall 2, via a fastening means 15, only which is indicated here. Within the housing 13 of the transmission brake 1 is situated an electromagnetically operating toroidal coil 6, 7 during the current supply of which an axially acting magnetic force is exerted upon a ring armature 8.

[026] The ring armature 8 is inserted either upon the outer plug-in toothing 10 of the transmission shaft 3 (version B) or upon the inner plug-in toothing 11 of the transmission housing 2 (version A) so that, according to an arrow 9, the ring armature 8 can be pressed by the magnetic force axially against the brake discs 4, 5 of the transmission brake 1. At the same time, the axial movement 9 of the ring armature 8 to te coil 6, 7 has an end when all brake discs 4, 5 are pressed against a stop face 14 on the housing 13 of the transmission brake 1. On the other hand, one fastening disc 12, which is fastened in the inner side of the transmission housing 2 or as a radially oriented spider 24 on the transmission shaft 3, limits the

axial motion of the ring armature 8 in direction to the interior of the transmission housing 2.

[027] In addition, the Figure shows that the coil 6, 7 is connected, via electric lines 19, 20, with a source of voltage. One control and regulation device 16 coordinated with the transmission brake 1, regulates the current supply of the coil 6, 7 depending on the rotational speed of the transmission shaft 3 to be braked. The drawing diagrammatically shows that this rotational speed can be determined, for example, with the aid of a gear wheel 23 upon the transmission shaft 3 and one rotational speed sensor 22 of which the measuring values are made available via a sensor line 21 of the control and regulation device 16.

[028] As soon as one data processing program stored in the control and regulation device 16 as result, among others, of the measured rotational speed information, has determined that the transmission brake 1 is to be actuated in the sense of releasing or braking the control device 16, via a control line 17, gives a control signal in the form of a pulse width modulated voltage to a driver stage 18 with which the current supply to the coil 6, 7 can be regulated.

[029] This embodiment makes clear that the transmission brake can also be implemented without a hydraulic or pneumatic actuation device. In addition, the integration of essential parts of the transmission brake in the transmission housing wall allows a very compact design.

[030] The inventive electromagnetic transmission brake 1 also makes very good adjustability of the countershaft rotational speed possible while, with the formerly known transmission brakes actuatable by pressure means, via the control of a magnetic valve of a piston-cylinder arrangement, the desired rotational speed of the countershaft can be controlled only roughly. In particular, by the proposed pulse width modulated regulation voltage, it is possible to adjust a control current in the toroidal coil 6, 7 of the inventive transmission brake 1, which is proportional to the braking force produced by the transmission brake. By way of the rotational speed control of the countershaft 3, it is thus possible to construct a regulation for the whole synchronization operation during a gear change with relative ease.

[031] The advantages of one such regulatable transmission brake are obvious. Thus, for example, a variable brake gradient can be adjusted with which the synchronization cycle is improved during a change of gear. With such a transmission brake, it is further possible also in itself to control switching cycles better than before.

[032] Furthermore, this regulatable transmission brake 1 can react directly to changing friction values of its friction elements 4, 5 and thereby, for example, take into account wear and overheating phenomena. Finally, the regulatable electromagnetic transmission brake 1 can also be used as a vibration damper in the drive train. At the same time, the transmission brake 1 is always briefly actuated when a disturbing increase of a vibration amplitude is felt in the drive train. In this manner, it is possible to omit a separate double solid flywheel when the transmission brake has been adequately laid out.

[033] With the inventive transmission brake is associated the further advantage that as a result of the adjustability thereof the friction element temperature can also be compensated. At the same time, the temperature compensation preferably is already a component of the control and regulation program stored in the control and regulation device.

[034] One other aspect of the invention concerns the regulatable braking force of the transmission brake so that it can be used for different transmissions without important structural changes. Needed adaptations are, as a rule, confined to a change of the control and regulation software in the control and regulation device and, when needed, a change of the number of brake discs.

[035] In one other development of the invention, the brake discs are designed so that their surface are corrugated, preferably sinusoidally corrugated, in peripheral direction. By such a construction an especially quick loosening of the friction elements from each other results when disconnecting the coil current so that the transmission brake under quick regulation instructions, can react with quick tightening and detaching operation.

[036] With the transmission brake introduced here, it is accordingly possible under to always implement an optimal synchronization operation under all marginal conditions.

Reference numerals

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| 1 | transmission brake | 13 | housing of transmission brake, cover |
| 2 | transmission housing wall | 14 | stop face |
| 3 | transmission shaft | 15 | fastening means |
| 4 | friction element: inner disc | 16 | control line and regulation device |
| 5 | friction element: outer disc | 17 | control line |
| 6 | toroidal coil | 18 | driver stage |
| 7 | toroidal coil | 19 | electric line |
| 8 | ring armature | 20 | electric line |
| | fastening element | 21 | sensor line |
| 9 | closing direction | 22 | rotational speed sensor |
| 10 | outer plug-in toothing | 23 | gear wheel |
| 11 | inner plug-in toothing | 24 | spider on transmission shaft |
| 12 | fastening disc | | |